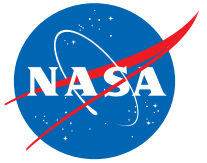
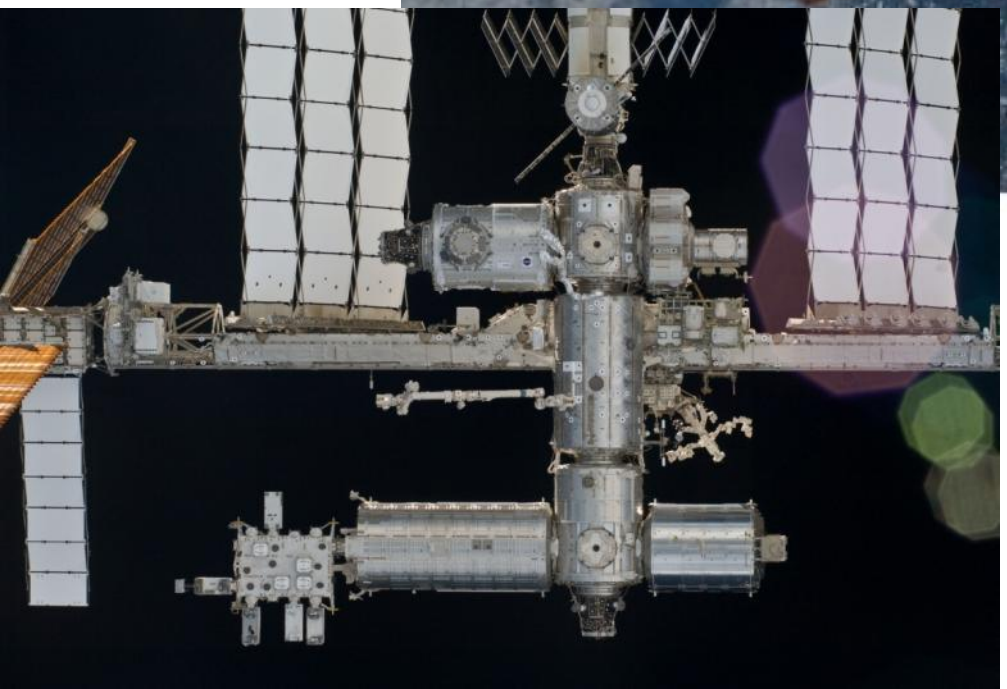
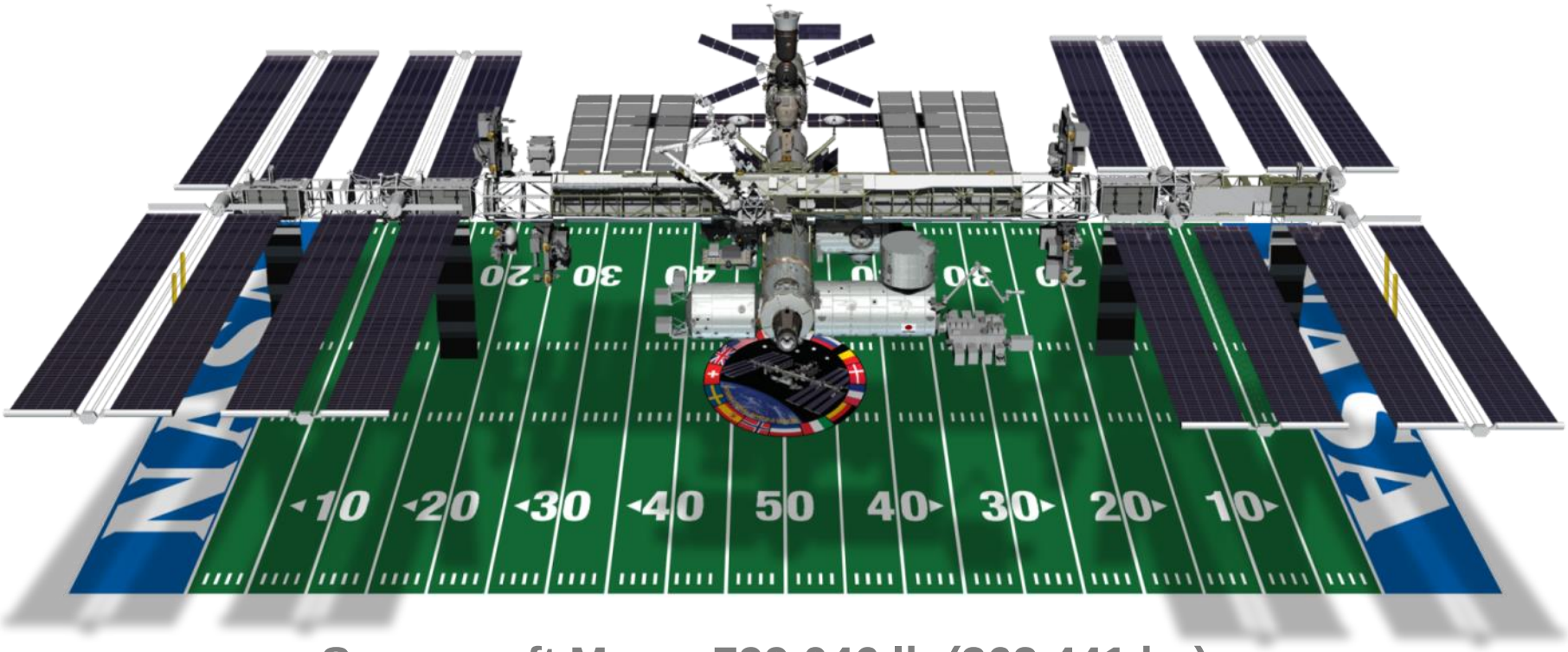


International Space Station Capabilities and Payload Accommodations



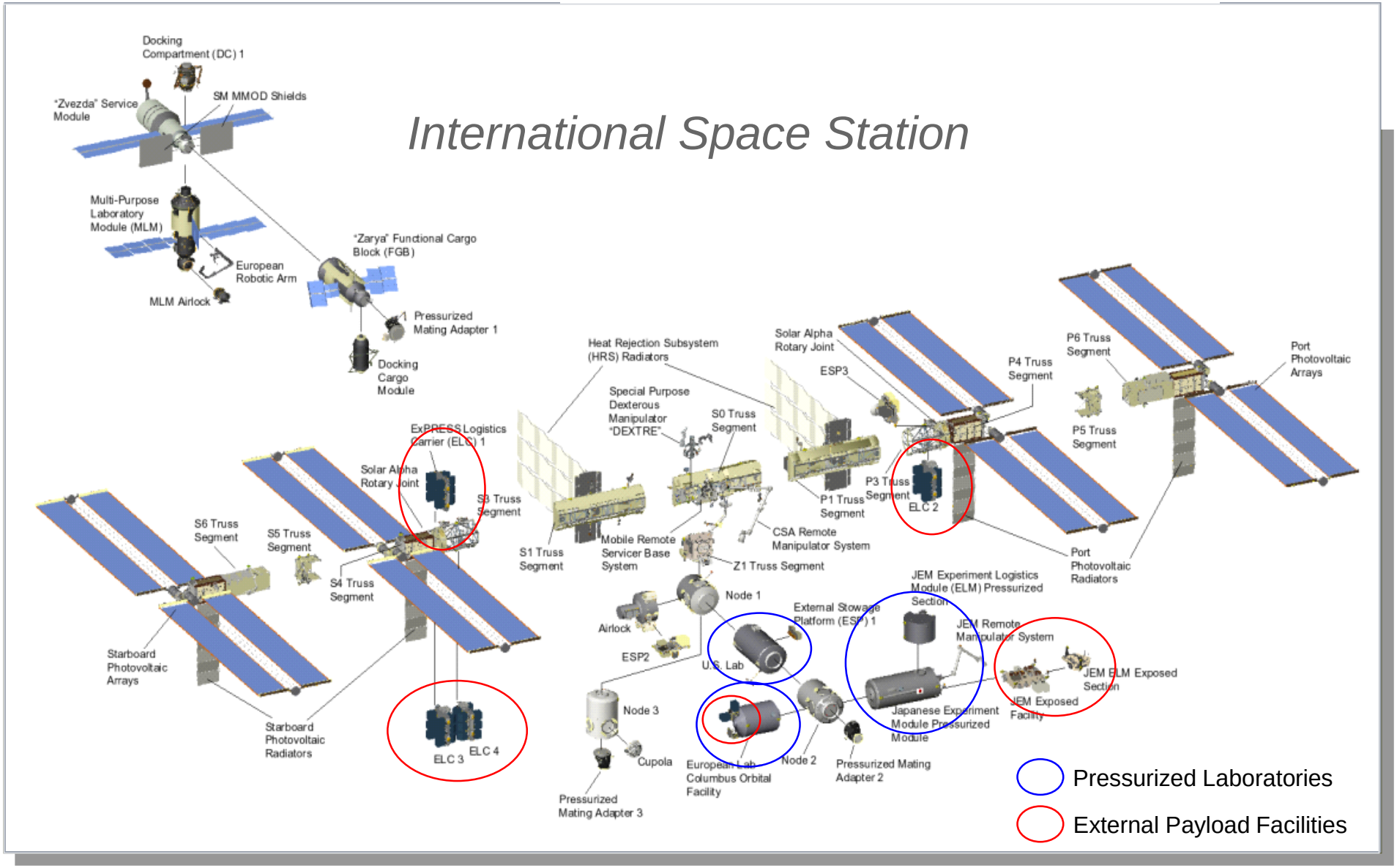
Current Stage

International Space Station Facts



Spacecraft Mass: 799,046 lb (362,441 kg)
Velocity: 17,500 mph (28,200 kph)
Altitude: 220 miles above Earth
Power: 80 kW continuous
Science Capability: Laboratories from four international space agencies – US, Europe, Japan, and Russia

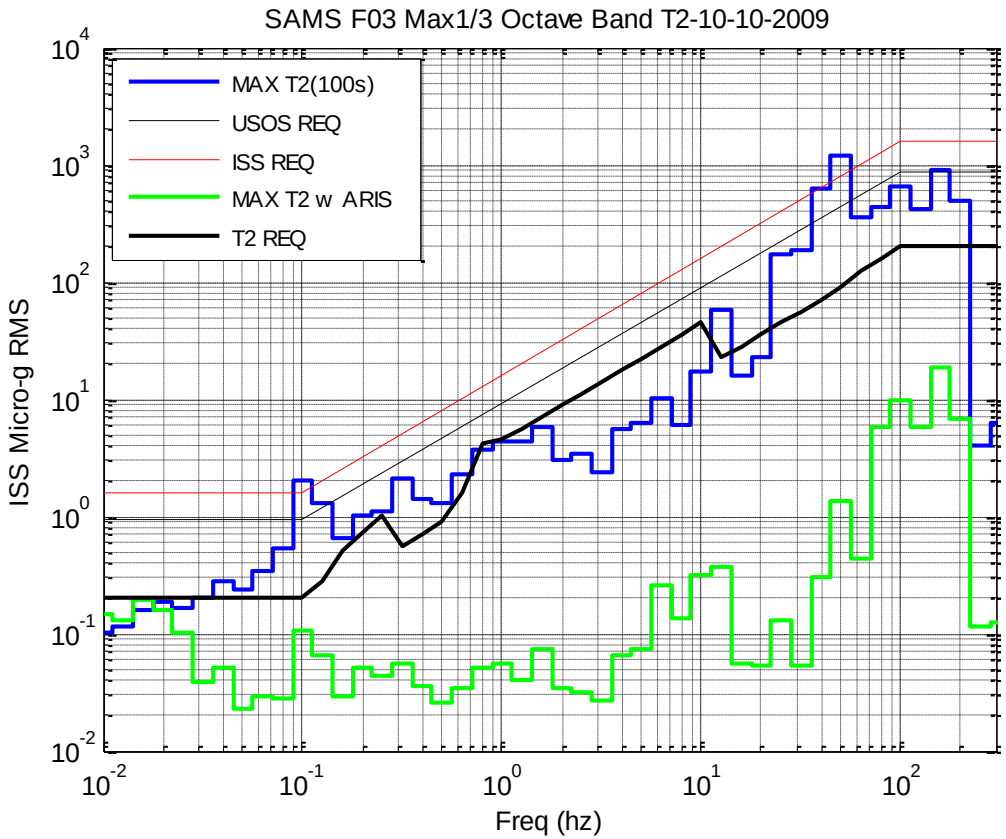
Assembly Complete Configuration

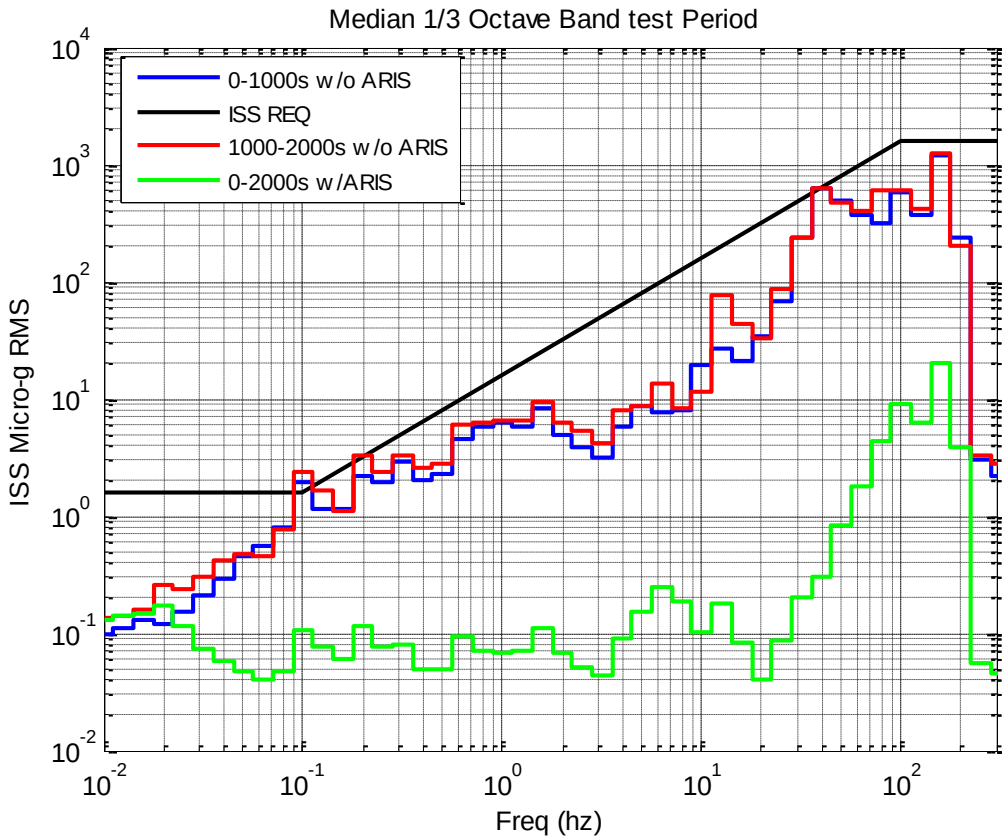


The Microgravity Environment

The ISS is equipped with an array of sensors that monitor perturbations to the microgravity state on-orbit.

Even without the Active Rack Isolation System, vibrations are typically within ISS requirements.





While the Station is at its most “quiet” during the eight hours of crew sleep, the Active Rack Isolation System can be effective even during crew exercise.

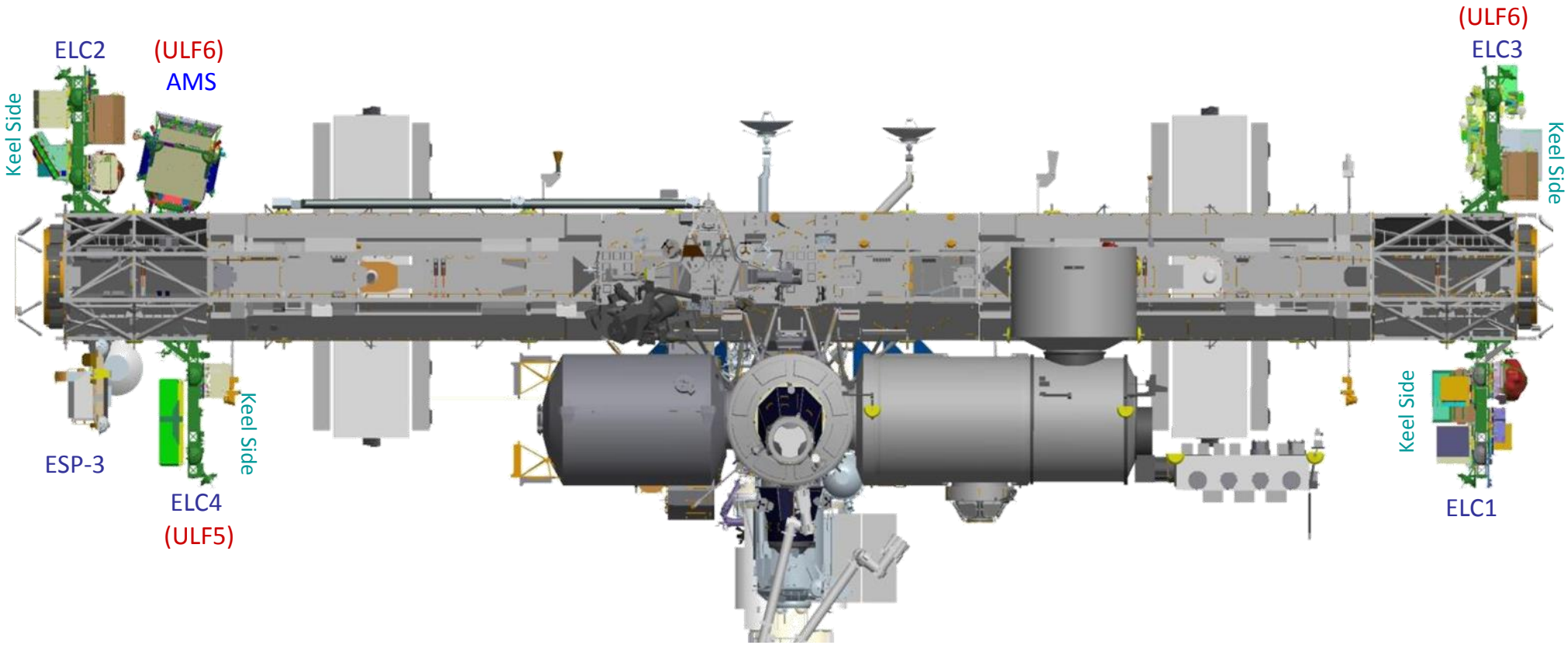
On Orbit Resources Provided to Payloads

Power	30kw average
Air to Ground Data	~37.5 Mbps of video (3 lines of video at 12.5 Mbps each)
	~8 Mbps of MRDL data (Science return)
	~5 Mbps for payload still imagery downlink
	~20 Mbps utilized for payload data recorded over LOS
Internal Racks	13 U.S. Lab
	5 ESA Lab
	6 JAXA Lab
External Sites	8 Truss ELC Platform Sites
	5 JAXA Platform Sites
	2 ESA Platform Sites
Crewtime	35 hrs per week (average)

Upgrades In Work

Enhanced Processor and Integrated Communications (EPIC) Project	Phase A will upgrade the three Command and Control (C&C) MDMs and the two Guidance, Navigation, & Control (GN&C) MDMs.
	Phase B will upgrade the two Payload MDMs, and add Ethernet support for the C&C and Payload MDMs.
Air to Ground High Rate Communications System (HRCS) Project	Increase data rates internally and on the RF link (300 Mbps downlink, 7/25 Mbps uplink)
	Combine audio and video on orbit
	Provide two way, high quality audio
	Open the door to internet protocol communications
	Open the forward link to multiple users
	Allow for the capability of transmitting & recording HDTV
On Orbit External Wireless High Rate	100 Mbps 2-way Ethernet capability
	1 Mbps 1553 capability
	Up to 4 antennas attached to EVA handrails on US Lab

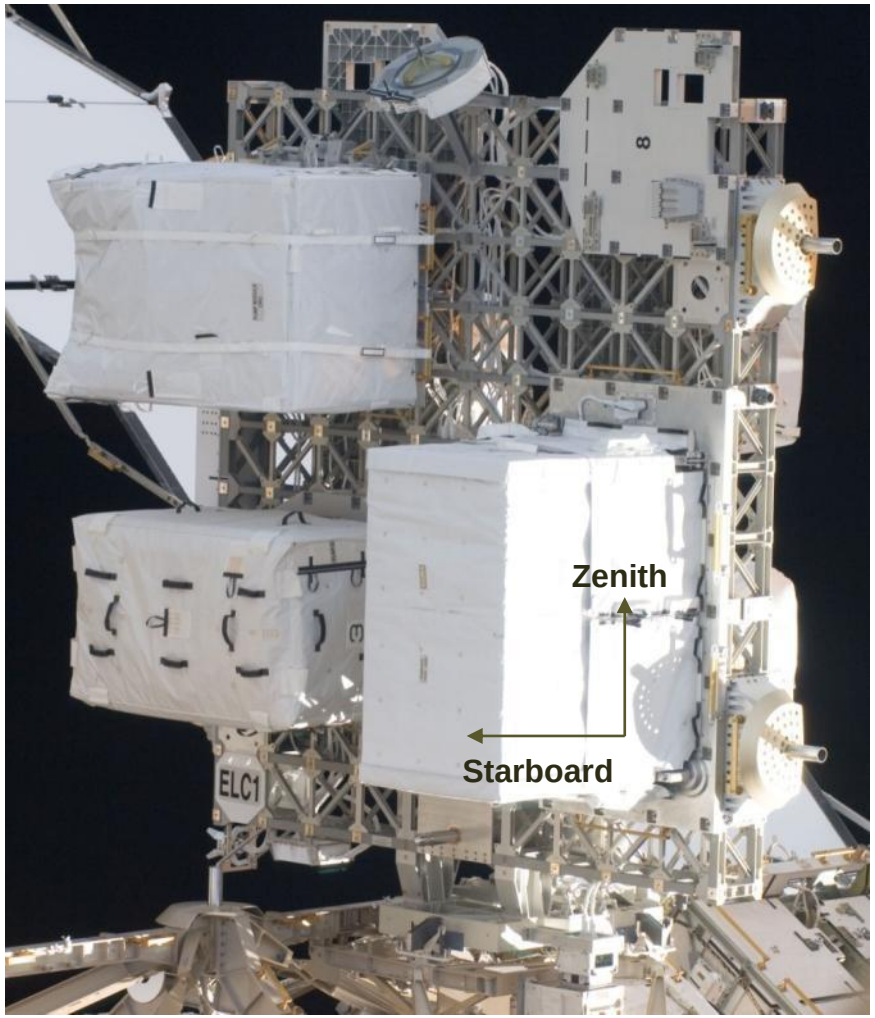
Truss Attach Site Usage



Recent ISS Assembly Science Facilities

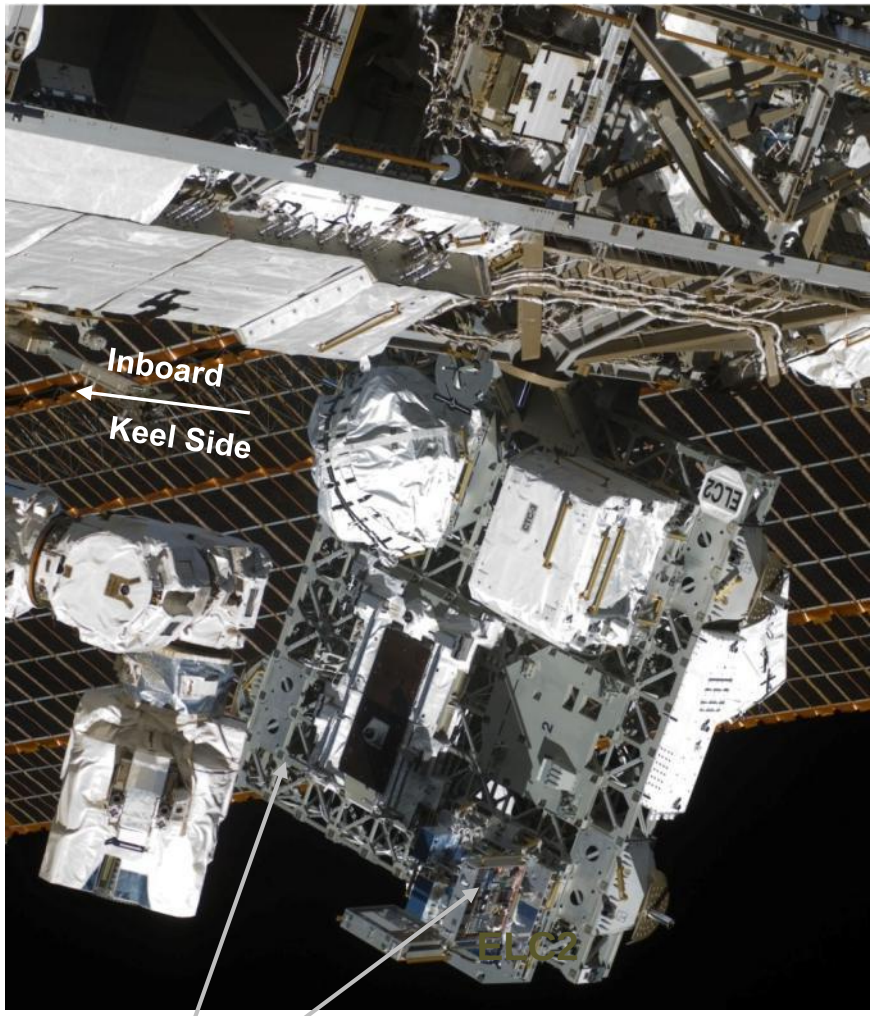
NASA Express Logistics Carriers (ELCs)

S3 Truss



ELC1, ELC3, & ELC4

P3 Truss

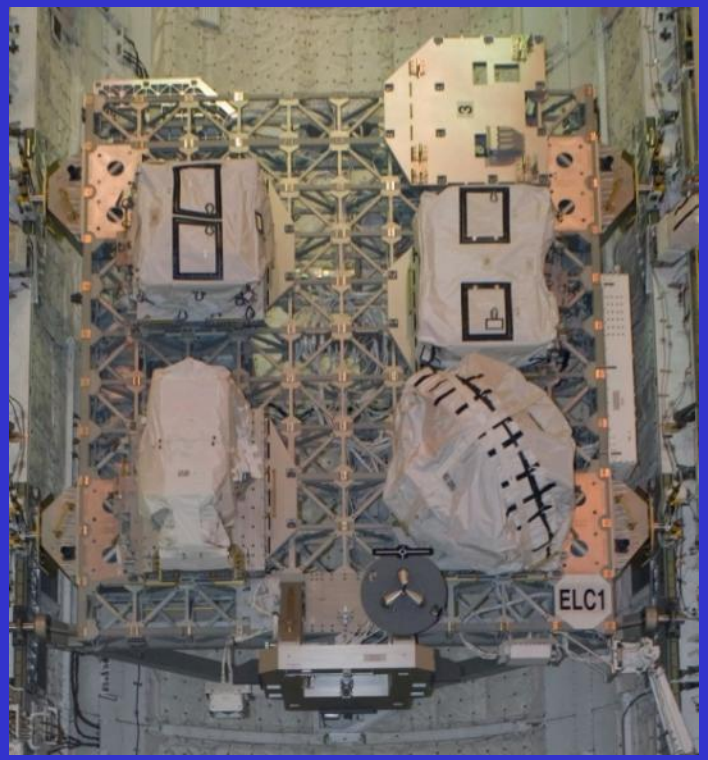


ELC2

2 payload sites per ELC

External Research Accommodations

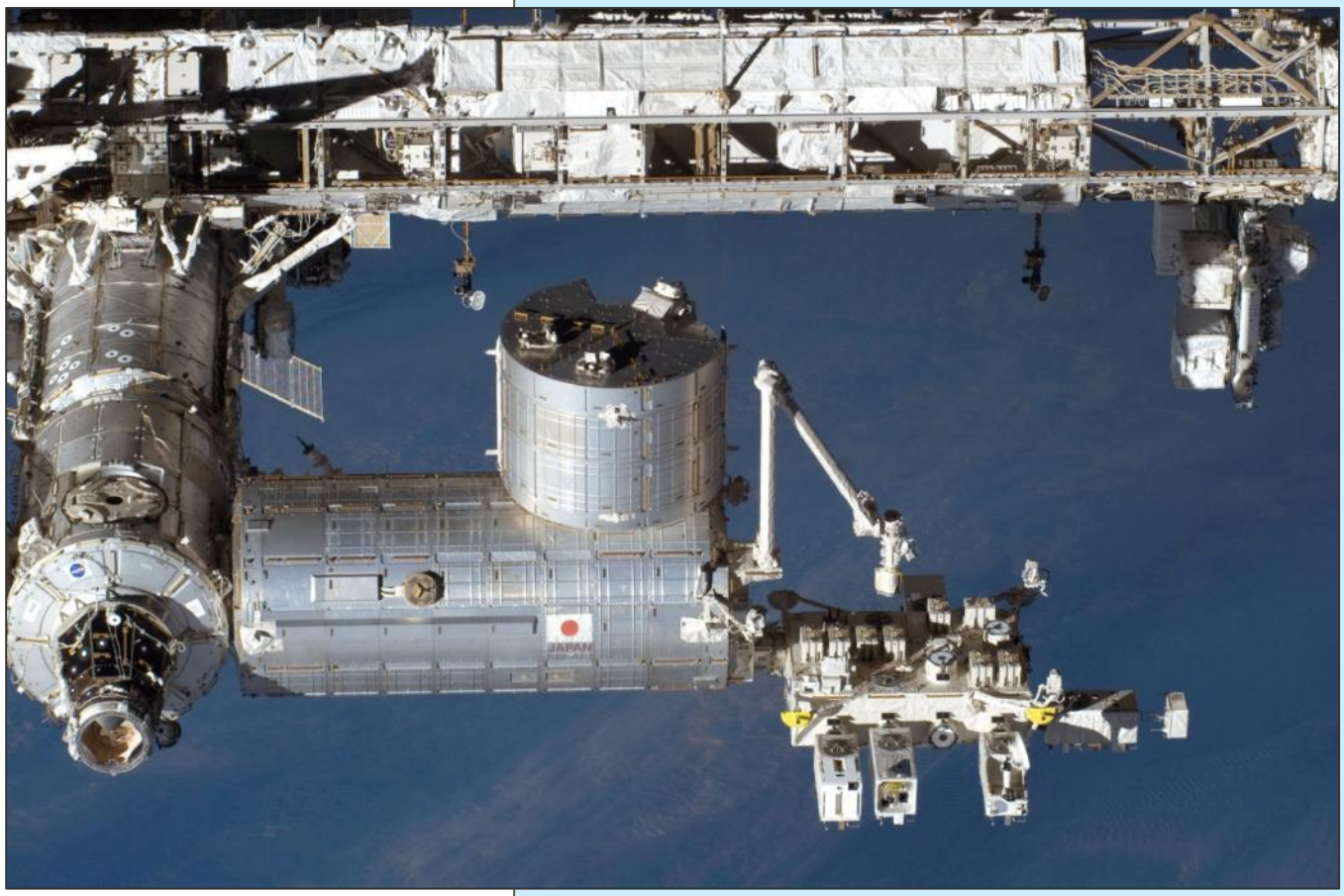
ELC Single Adapter Resources



Mass capacity	227 kg (500 lb)
Volume	1 m^3
Power	750 W, 113 – 126 VDC; 500 W at 28 VDC per adapter
Thermal	Active heating, passive cooling
Low-rate data	1 Mbps (MIL-STD-1553)
Medium-rate data	6 Mbps (shared)
Sites available per ELC	2 sites
Total ELC sites available	8 sites

Recent ISS Assembly Science Facilities

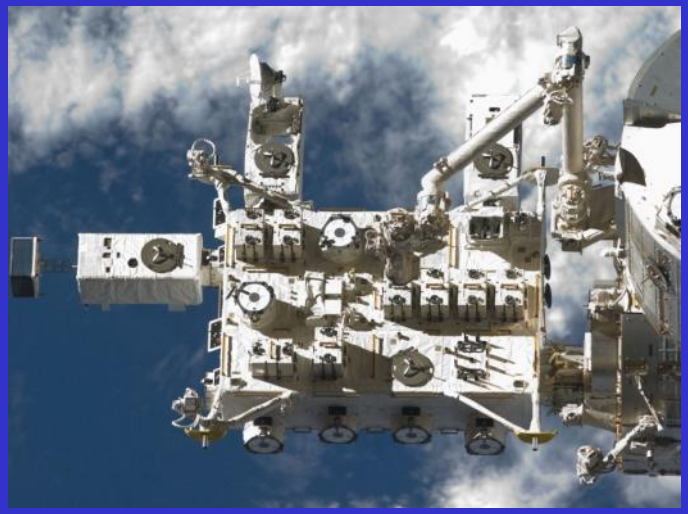
Japanese Experiment Module - Kibo



- *5 external payload sites allocated to NASA on the JEM Exposed Facility*
- *6 internal active payload rack locations allocated to NASA inside the JEM Pressurized Module*

External Research Accommodations

JEM-EF Resources



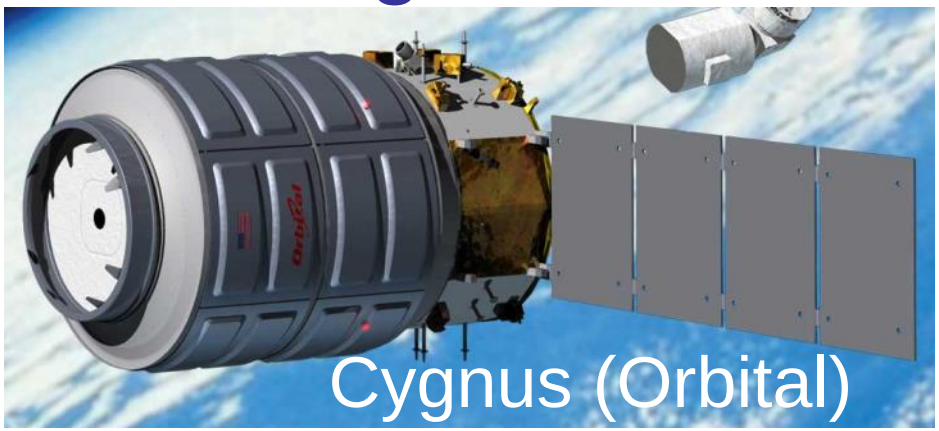
Mass capacity	550 kg (1,150 lb) at standard site 2,250 kg (5,550 lb) at large site
Volume	1.5 m^3
Power	3-6 kW, 113 – 126 VDC
Thermal	3-6 kW cooling
Low-rate data	1 Mbps (MIL-STD-1553)
High-rate data	43 Mbps (shared)
Sites available to NASA	5 sites

External Research Accommodations

Columbus External Resources

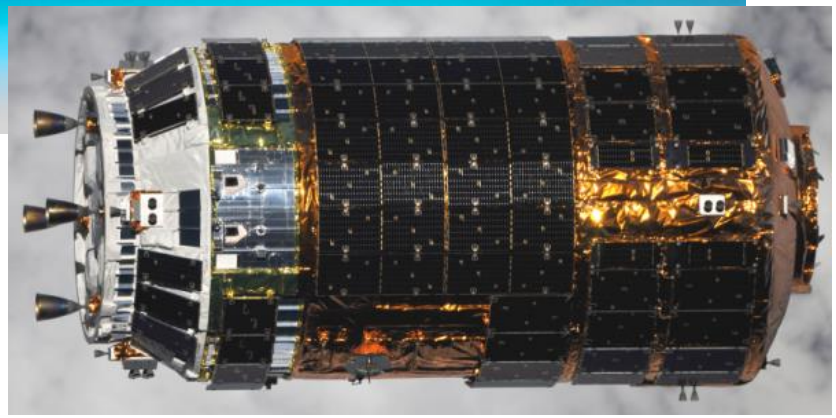
Mass capacity	230 kg (500 lb)
Volume	1 m^3
Power	2.5 kW total to carrier (shared)
Thermal	Passive
Low-rate data	1 Mbps (MIL-STD-1553)
Medium-rate data	2 Mbps (shared)
Sites available to NASA	2 sites

ISS Visiting Vehicles Post-Shuttle



Progress/Soyuz (Energia)

HTV (JAXA)



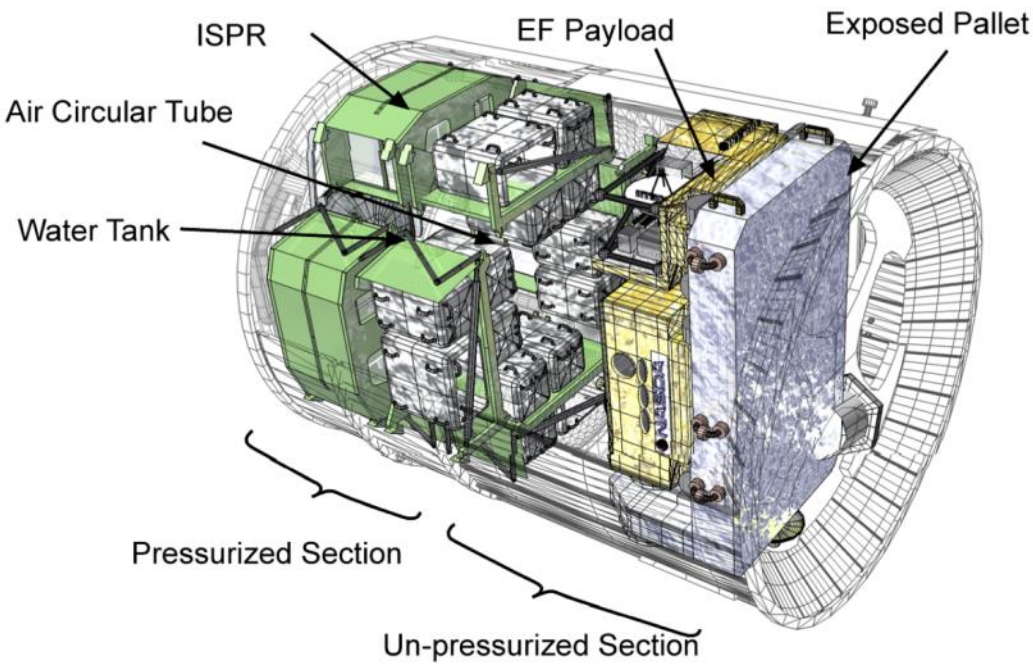
HTV

Upmass

- Internal
  - Powered: None
  - Late Load
    - » Maximum 3 CTBE (0.5 or 1.0 CTB), each <20 kg
    - » Additional possible if negotiated in advance.
  - Racks
    - » Up to 8 passive racks
    - » Forward Bay: ISPR compatible
    - » Aft Bay racks fixed: HTV Resupply Rack
- External
  - Exposed Pallet (on following chart)
- On Dock
  - Cargo: L-6 months
  - Late Load: L-6 weeks

Downmass

- Internal
  - Disposal only
- External
  - Disposal only



HTV External Pallet Configurations

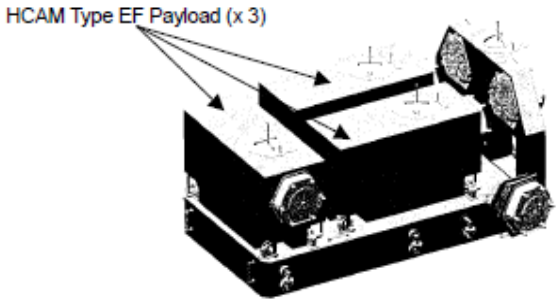


Fig. 3.3.2-1 Type I-a: HCAM Type EF Payload (x 3)

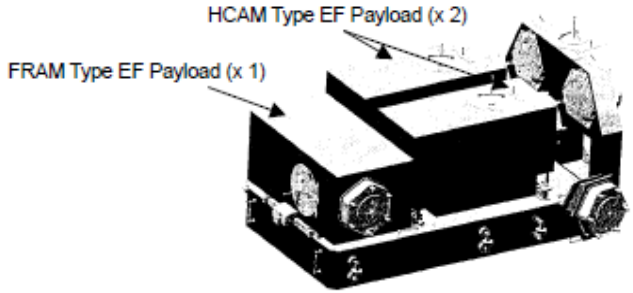


Fig. 3.3.2-2 Type I-b: HCAM Type EF Payload (x 2) and FRAM Type EF Payload (x 1)

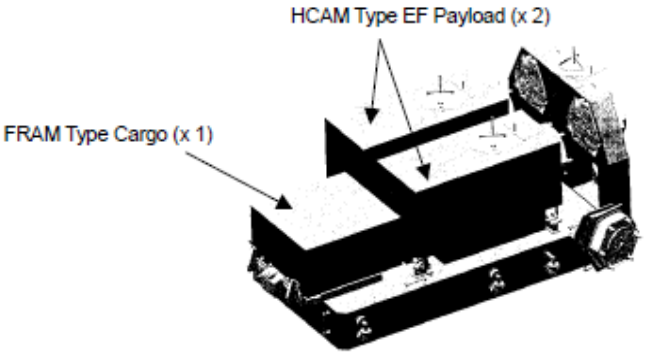
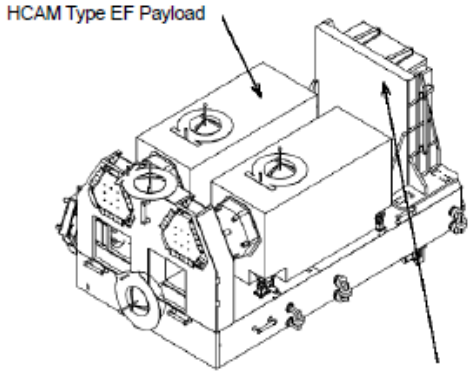


Fig. 3.3.2-3 Type I-b': HCAM Type EF Payload (x 2) and FRAM Type Cargo (x 1)



TBD
(Battery Transportation Demonstration)

Fig. 3.3.2-4 Type I-c: HCAM Type EF Payload (x 2) and Battery Transportation Demonstration (x 1)

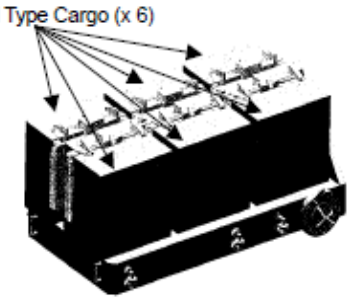


Fig. 3.3.2-5 Type III-a: FRAM Type Cargo (X6)

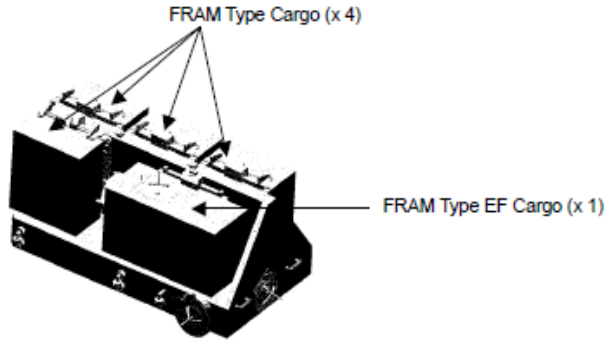


Fig. 3.3.2-6 Type III-b: FRAM Type EF Payload (X1) and FRAM Type Cargo (X4)

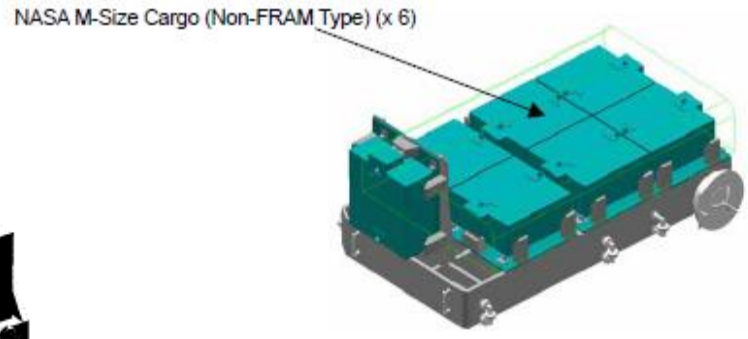


Fig. 3.3.2-7 Type III-c: Non-FRAM Type Cargo (X6)

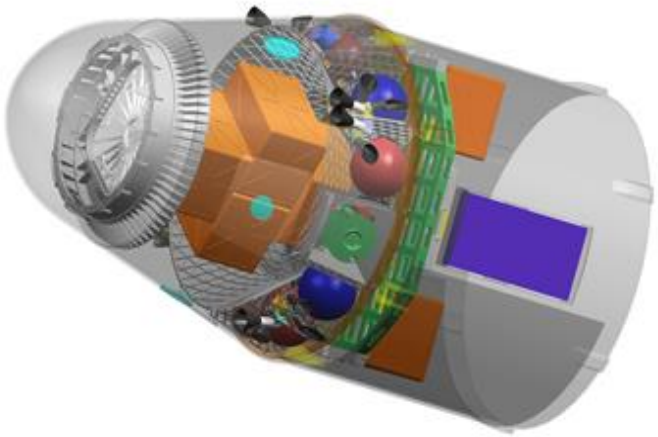
Dragon

Upmass

- Internal
  - Powered: Double MLE
  - Late Load: T-12 hrs for powered MLE; TBD days for nominal
  - Racks (SpaceX-designed)
    - » ~3300 kg mass
- External
  - Trunk capability

Downmass

- Internal
  - Powered: Double MLE
  - ~1700 kg return
  - Early destow at dock available
  - Fast boat return available
- External
  - Disposal only



ISS Feasibility Assessments

Data Required

- Upmass needed
- Power consumption
- Data rates
- Pointing/viewing needs
- Lifetime required on orbit
- Return plan

ISS Feasibility Assessment Evaluation Criteria

- In performing the feasibility assessments, the ISS payloads office looks at whether or not the proposed payload meets the standard interfaces or requires significant non-standard integration
- For example, the volumes are defined for each platform but there are specific dimensions that make up those volumes
  - Working with the proposer, we will evaluate the dimensions and determine if the payload is within the standard dimensions or exceeds those dimensions in one or more areas
  - If it exceeds the standard interfaces, we will provide an evaluation of how simple or hard it will be to accommodate those non-standard interfaces
  - The proposer will be made aware of any non-standard interfaces to determine if they can redesign to stay within the standard interfaces
  - A lot of times, non-standard interfaces CAN be accommodated but it requires additional work

ISS Payload Requirements

- ISS payload requirements do not flow from NPR 8705.4 and thus the Class A/B/C/D levels are not directly applicable
- For the ISS requirements, payload success is not part of the requirements set, although it may very well be a requirement for the Science Mission Directorate
- Many requirements of Class D payloads are acceptable to ISS, however, in a number of areas, the man rating requirements will be stricter and more like Class A requirements
- If a payload is selected for an ISS mission of opportunity, the ISS payloads office will work with the payload developer to develop the set of requirements that must be verified to fly on an ISS transportation vehicle and on the ISS

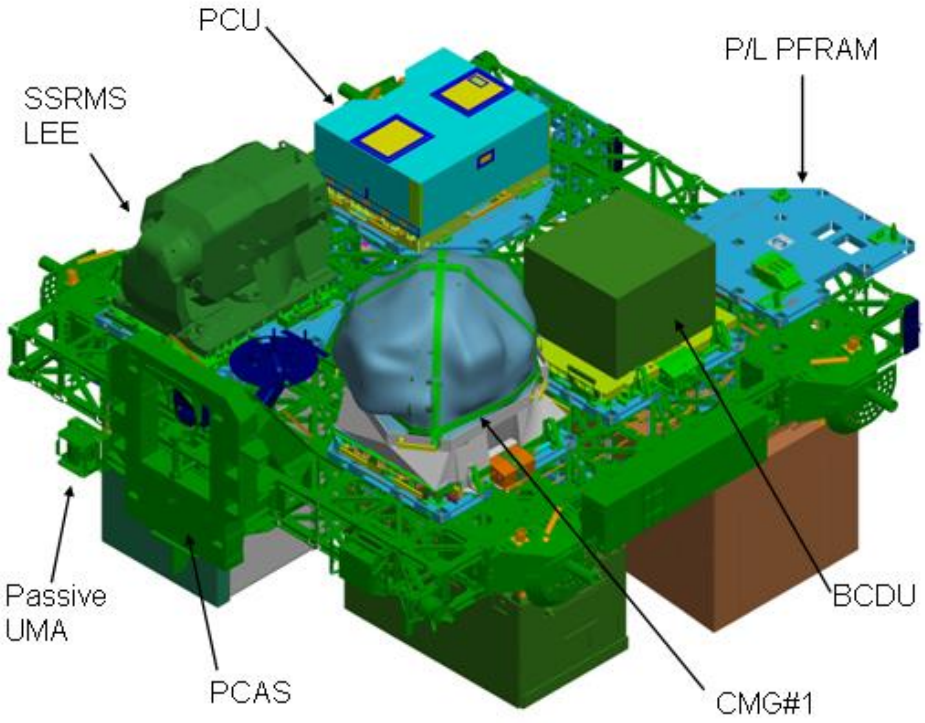
References

- ISS Program Scientist Toolbox - http://iss-science.jsc.nasa.gov/index.cfm
- ISS National Laboratory Office - http://www.nasa.gov/mission_pages/station/science/nlab/index.html
- Advanced Avionics Development Office - http://iss-www.jsc.nasa.gov/nwo/avionics/aado/home/web/
- Attached Payload Interface Requirements Document, SSP 57003
- Common Interface Requirements Document, SSP 50835
- ATV-2 Cargo Summary (24 Sep 2009)
- HTV Cargo Accommodation Handbook, JFX-99102
- Requirements for International Partner Cargo Transported On Russian Progress and Soyuz Vehicles, П32928-103
- SpaceX Introduction For Payloads (OZ3, Jan 2010)
- Cygnus Fact Sheet (Orbital, 2009)

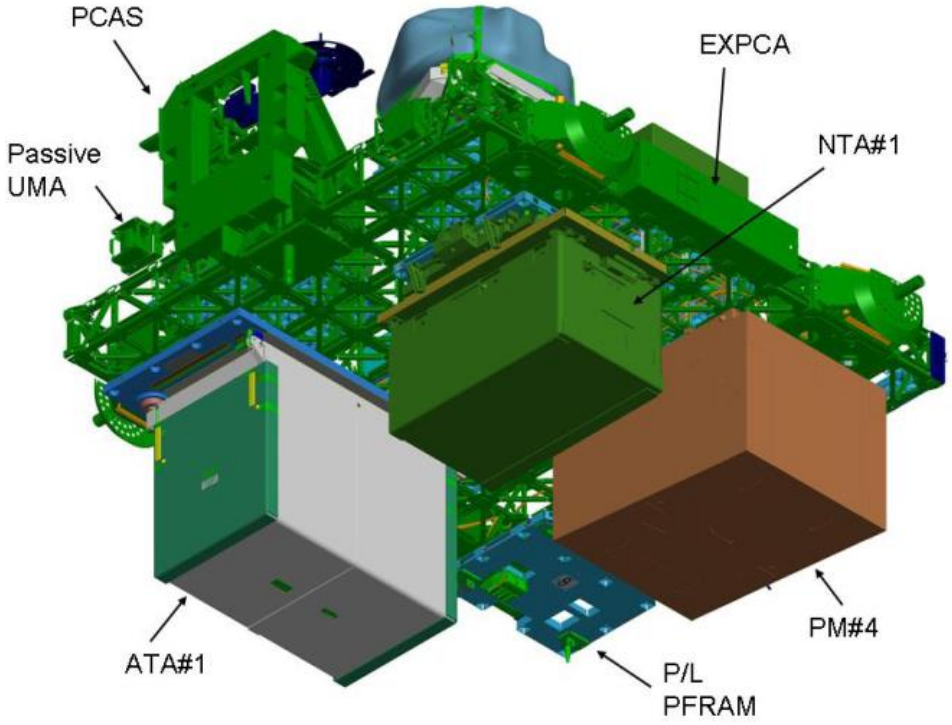
Backup

Science Facilities Overview

ELC1 Configuration

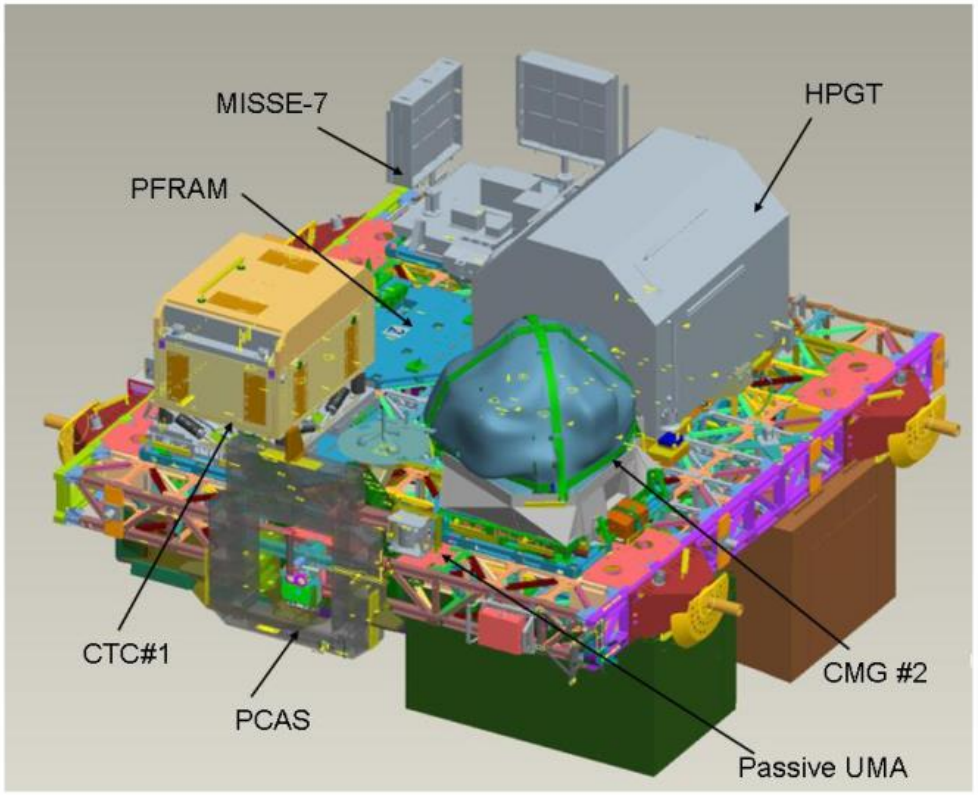


ELC1 Top Side

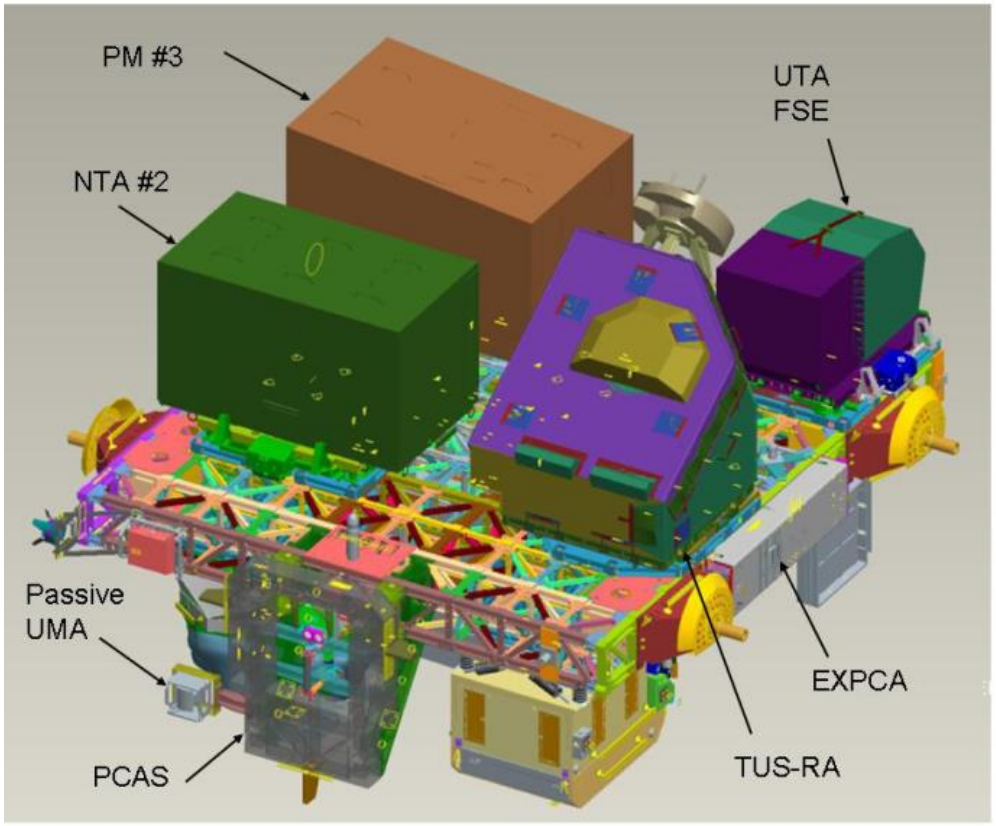


ELC1 Keel Side

ELC2 Configuration



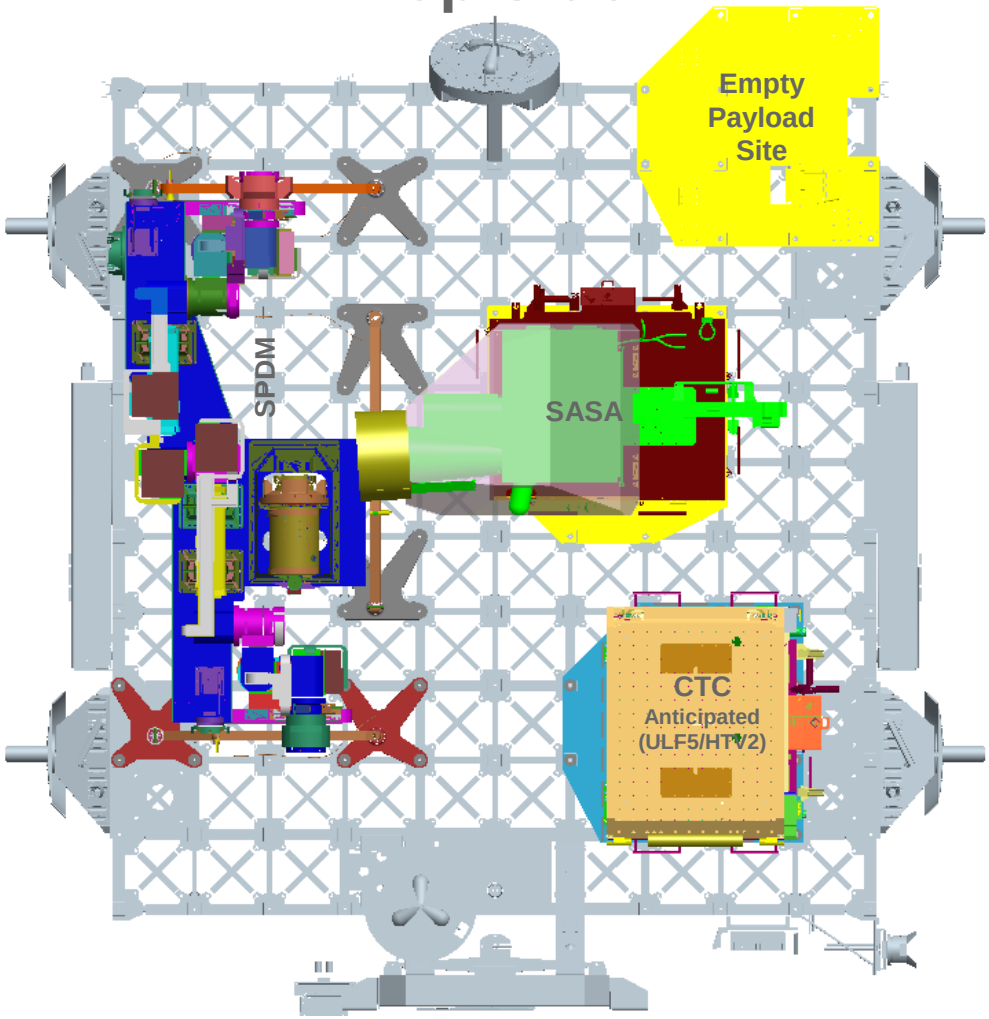
ELC2 Top Side



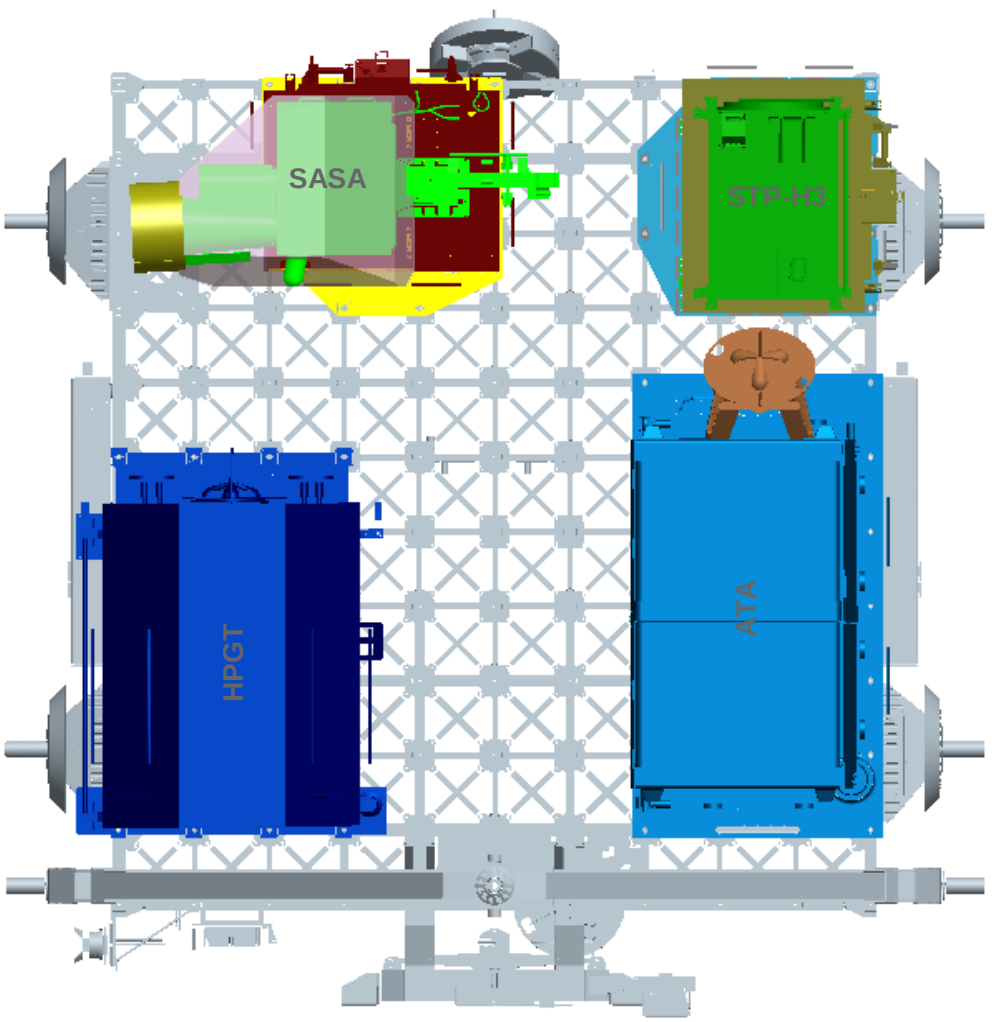
ELC2 Keel Side

ELC3 Configuration

Top Side

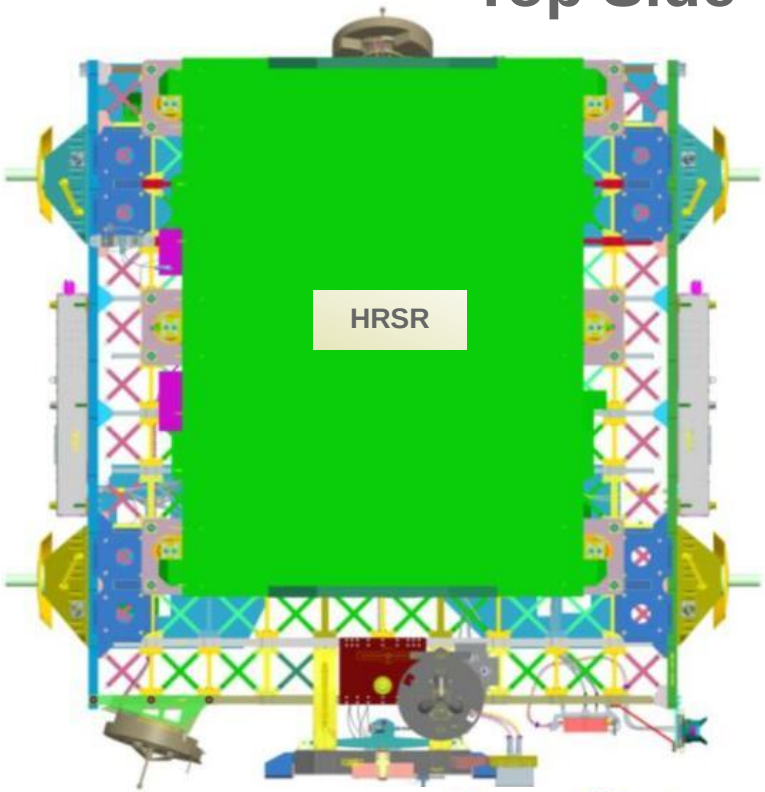


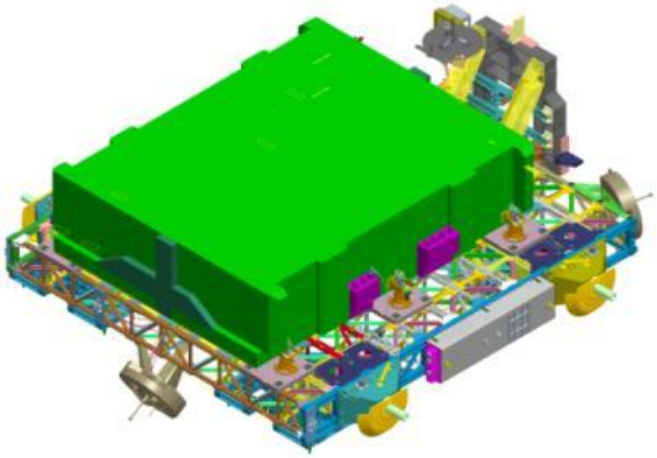
Keel Side



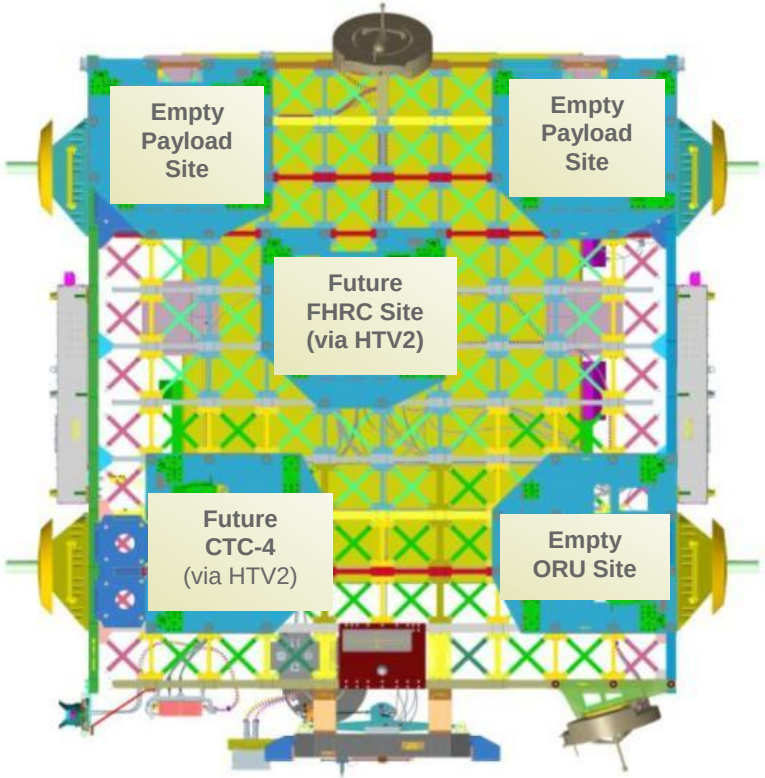
ELC4 Configuration

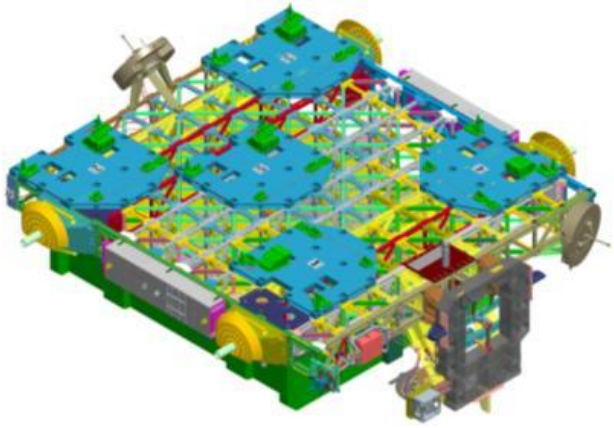
Top Side



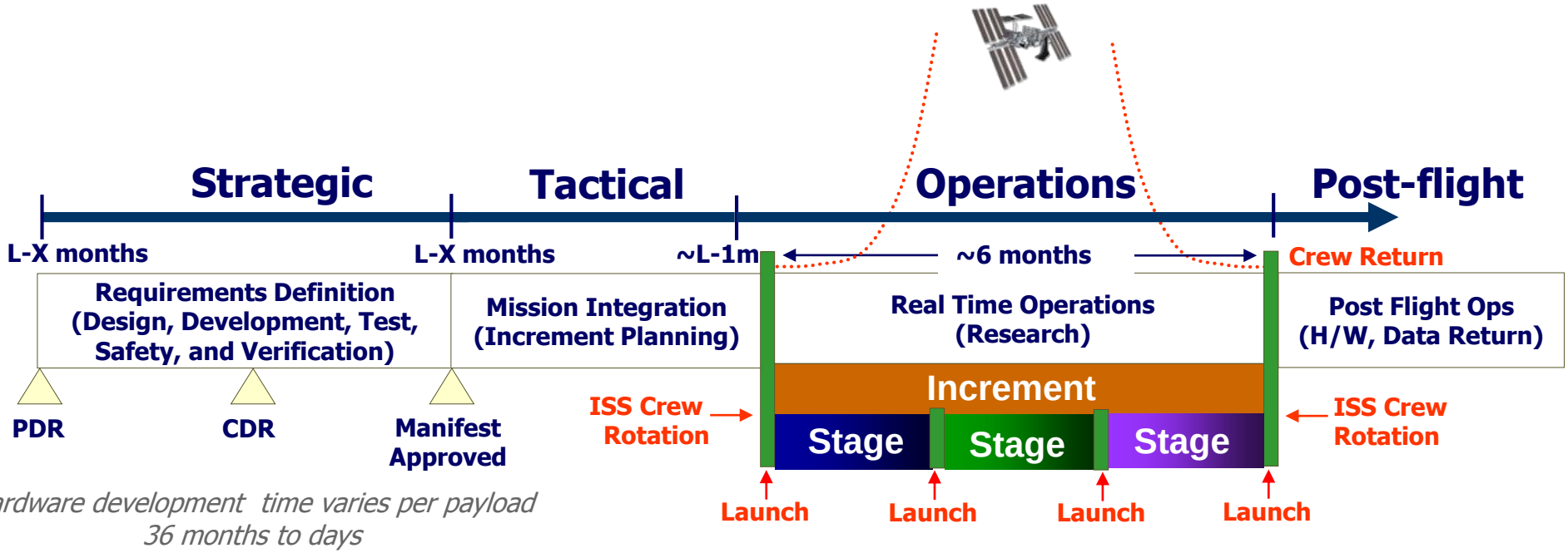


Keel Side



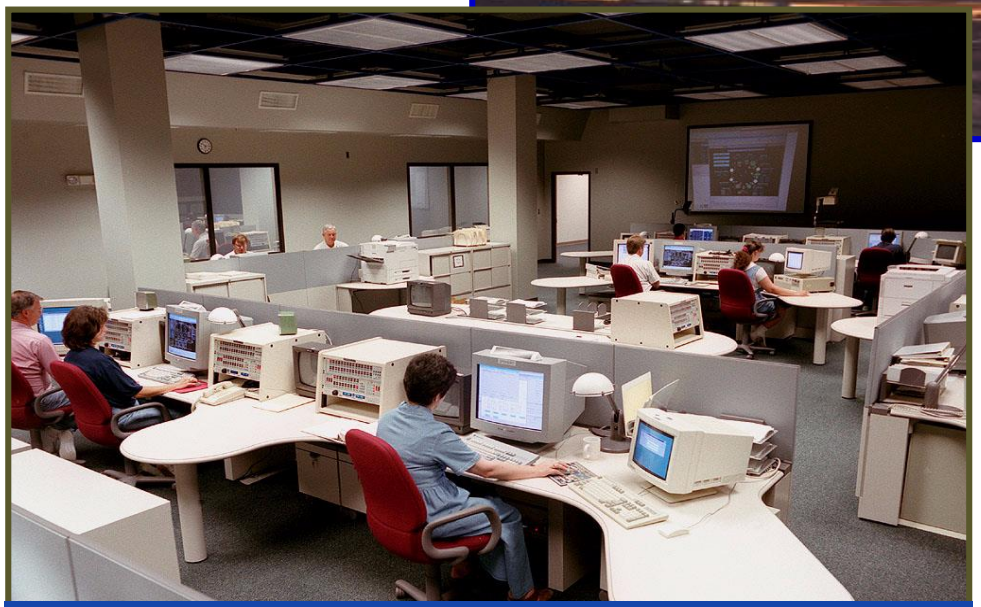


ISS Payload Integration Process



Hardware development time varies per payload
36 months to days

ISS Payload Control Centers

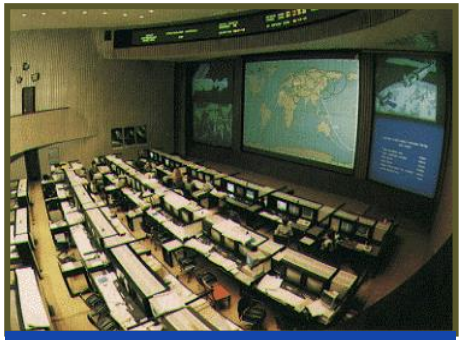


Payload Operations Center (POIC) - Huntsville

POIC: Responsible for execution of on-orbit NASA research

Mission Control Center—Houston

MCC-H: Responsible for flight command and control of overall vehicle



Mission Control Center—Moscow

MCC-M: Responsible for flight command and control of Russian segment.

Payload Ops Integration Center Interfaces

MCC-H, 4 IP Control Centers, 4 Telescience Support Centers, 49 Telescience Resource Kit (TReK) clients

TDRSS

Space Shuttle

ISS

White Sands Complex, New Mexico

Commands, Uplinks, Voice

Vehicle Telemetry, Voice, Video

Payload/Kuband & Vehicle Telemetry

Mission Control Center Houston

Commands, Uplinks

Planning Products, Voice, Ops Mgmt, Other

Payload Ops Control Center Huntsville

US Payload Commands, Uplinks

Payload/Kuband & Ancillary Telemetry

Planning Products, Voice, Ops Mgmt,

Internet

MCCH to International Partner Services

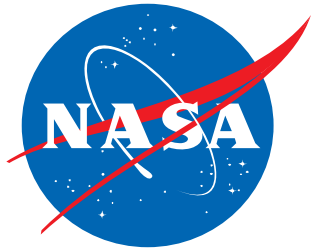
International Partner Facilities

Russia
Europe
Japan
Italy
Canada

GRC
ARC
JSC
MSFC

NASA Telescience Support Centers

Payload User Sites TReK


NASA